BUILDING A PROPULSION EXPERIMENT PROJECT MANAGEMENT ENVIRONMENT

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ABSTRACT

What do you get when you cross rocket scientists with computer geeks? It is an interactive, distributed computing web of tools and services providing a more productive environment for propulsion research and development. The Rocket Engine Advancement Program 2 (REAP2) project involves researchers at several institutions collaborating on propulsion experiments and modeling. In an effort to facilitate these collaborations among researchers at different locations and with different specializations, researchers at the Information Technology and Systems Center,[1] University of Alabama in Huntsville, are creating a prototype web-based interactive information system in support of propulsion research. This system, to be based on experience gained in creating similar systems for NASA Earth science field experiment campaigns such as the Convection and Moisture Experiments (CAMEX), will assist in the planning and analysis of model and experiment results across REAP2 participants. The initial version of the Propulsion Experiment Project Management Environment (PExPM) consists of a controlled-access web portal facilitating the drafting and sharing of working documents and publications. Interactive tools for building and searching an annotated bibliography of publications related to REAP2 research topics have been created to help organize and maintain the results of literature searches. Also work is underway, with some initial prototypes in place, for interactive project management tools allowing project managers to schedule experiment activities, track status and report on results. This paper describes current successes, plans, and expected challenges for this project.

INTRODUCTION

The Information Technology and Systems Center (ITSC) at the University of Alabama in Huntsville (UAH), has a long history of working with data interoperability problems related to Earth science research and data management issues [Ramachandran 2001]. The Earth science domain has issues that include the production of large amounts of data (terabytes per day), widely varying data formats across products and research efforts, a lack of overall communication or cooperation among researchers, and an issue of long distance between researchers when collaborations do exist. While we have experienced and dealt with all these problems in the Earth science domain, these are obviously not all unique to that group.

Through our recent involvement with the Rocket Engine Advancement Program 2 (REAP2) project at UAH, the similarity of issues and concerns between the propulsion research domain and other research areas such as Earth science is becoming apparent although there are obviously propulsion-specific issues. The REAP2 project is specifically focusing on close collaboration between several university propulsion research centers, but it is obvious that this is not necessarily the norm outside of this project where an apparent tendency towards isolationism exists. Where the Earth science domain generated huge volumes of data on a continuous basis through remote sensing platforms such as satellites, propulsion researchers generate large amounts of data on the basis of specific experiment or model-run events. The properties of the

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data are not that different between the domains, with imagery and physical property readings like temperature and pressure, but the scale and resolution is typically much finer in the propulsion domain, resulting in large data volumes over a shorter temporal period. There does not appear to be the emphasis on data sharing or availability within the propulsion community, but that probably relates back to the isolationist research tendencies mentioned earlier and maybe from a current lack of good tools to facilitate the easy dissemination of data, experiment results and related information. This lack of collaboration is where we believe information technologies can provide important services and benefits to the propulsion research community.

Compounding the tendencies toward non-collaboration in the propulsion research community is a hesitation to embrace internet-based tools and services for the dissemination of information and the collaboration of efforts. While propulsion researchers have made excellent use of high performance computing technologies for analytical purposes, the use of Internet and web-based communications, collaborations and data exchanges has not been universally accepted.

Web-based tools can be a very effective way of promoting collaboration once the participants are comfortable with the approach. Web collaboration tools such as portals that provide document and data sharing as well as project management and communication tools are becoming more user-friendly and reliable which improves the acceptance within groups who want the services but not the hassle of configuration and management. In this paper we suggest some examples of collaborative systems developed for other research efforts and then describe what is being prototyped and planned specifically for propulsion research.

Like any domain, propulsion research has characteristics unique to the area that need to be addressed with customization of off-the-self solutions. For instance propulsion data and test results vary widely in terms of format and size and are often unique within a particular research group. This limits the ability to have generalized data handling or visualization, and requires that data interchange include more detailed description from originating investigators. Unlike other research areas, security becomes an important consideration at some levels of propulsion research that may address national security issues. This levies additional requirements on web collaboration to provide varying levels of security controls that are definable by project managers.

THE REAP2 PROJECT

The Rocket Engine Advancement Program (REAP) 2 program is a university propulsion consortium that has been created to bring the appropriate skills to bear from researchers who are well established and known in the propulsion community. The core team provides the knowledge base, research skills, and commitment to achieve an immediate and continuing impact on Next Generation Launch Technology (NGLT) propulsion issues. The initial REAP2 research emphasis is on Combustion Stability and Thrust Chamber Cooling. The research is accomplished through integrated research teams composed of analysts, diagnosticians, and experimentalists working together in an integrated multi-disciplinary program. The principal university participants include: Prof. Clark W. Hawk, UAH, Profs. Charles L. Merkle and Stephen D. Heister, University of Tennessee Space Institute, Prof. Essam Ibrahim, Tuskegee University, Prof. Winfred A. "Butch" Foster, Jr., Auburn University, and Prof. Robert J. Santoro, Penn State University. Additional colleagues and students from their respective universities have joined them to meet the needs of the planned research program.

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Since the beginning of the project, coordination of activities such as the preparation of reports and publications, and the sharing of research results has been a challenge with so many participants separated by long distances. Attempts were made to coordinate reports through email and attachments, but this became increasingly difficult as the size of files become too large and email security restrictions complicate communications and individual email lists were sometimes incomplete. It has been necessary to get team members together at least quarterly for status and progress reports between themselves and the NASA sponsors, but this is an expensive undertaking with this many participants, especially when upwards of twenty graduate students are also actively involved with various aspects of the ongoing research. The need for electronic collaboration was apparent early on for this project and fortunately the team leader had the foresight to pursue and embrace possible solutions from the beginning.

COLLABORATIVE SYSTEMS

There have been great advances in information technologies addressing electronic collaboration solutions. Several types and examples are mentioned in the following section.

PORTALS

Typical web pages consist primarily of informational content, either static or in some cases dynamic, but either way with the primary purpose of providing pre-defined information. Recent trends and support for web sites referred to as portals has spurred the development of sites that bring functional sites that provide services of special interest to targeted groups. An example (see figure 1) is the OpenGIS portal (portal.opengis.org) that specifically targets developers and users of geographic information systems. This portal provides the latest information on current developments in geographic information specifications, tools, meetings and research funding opportunities, with different levels of access depending on the membership status of users (i.e. public and private areas, voting versus non-voting member services), schedules of events, publications, and links to related sites of interest to participants.

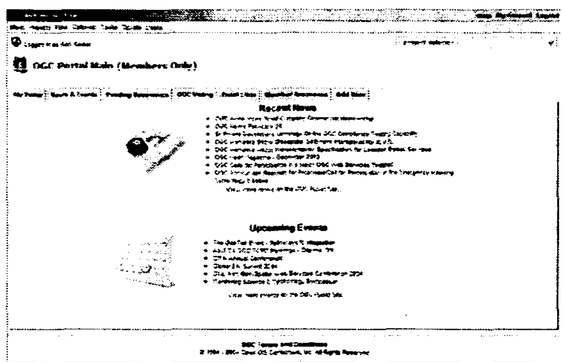


Figure 1: Example portal user interface

The broad acceptance of this type of special-interest sites has spurred the availability of portal development platforms that provide the building blocks of functionality that are in common across most portals, such as schedules/calendars, message boards, publication lists, etc. Some example platforms that are available include uPortal that is provided free by the Java Architectures and Special Interest Group (JA-SIG). This portal platform provides functionality geared toward educational institutions and contains a wide array of tools for customization, allowing the site developer to incorporate a near limitless variety of content depending upon the needs of a particular portal site. Another platform provided for free by its developers is the dotProject platform which is geared more toward use by small companies or research groups and includes built in functionality for creating calendars, message boards, and project areas where individuals or groups can place information on current or pending projects.

Other platforms are provided commercially and are intended for large scale use such as IBM's Websphere and Bowstreet portlet factory. These products are meant to speed development time for portals and to significantly increase the usability of individual areas within portals so they may be re-used in other areas or updated with relatively little effort.

There are many worthwhile products for the creation and maintaining of portals on the market, and each has its individual strengths and weaknesses, and many such as uPortal and dotProject are geared toward specific areas of interest. All of them focus on the idea of creating small blocks of functionality that can then be "plugged into", or taken out of the portal at any time. In this way, multiple users can have content tailored to their specific needs within the same web portal.

GRID TECHNOLOGIES

There is increasing interest in the use of networks not just for communication or remote data access, but also for the coupling of computers, instruments, data archives, etc., with each other and with humans. This level of information sharing is now commonly being referred to now as an information "Grid". The real and specific problem that underlies the Grid concept is coordinated resource sharing

and problem solving in dynamic, multi-institutional virtual organizations [Foster, 2001]. Some of the Grid solutions include collaborative environments, distributed computing, computer-enhanced instrumentation, distributed data mining, digital libraries, and problem solving environments [Graves 2003].

Within the scientific community, this interest has led to new "Grid" initiatives such as the NASA Information Power Grid [Hinke 2000], NCSA Alliance National Technology Grid, NPACI metasystems, DOE Collaboratories, DOE ASCI DISCOM, etc., as well as the establishment of focused community forums concerned with, for example, the use of Java for high-performance computing (Java Grande Forum), desktop access to remote resources (DATORR), component architectures, (CCA Forum), etc.

The Linked Environments for Atmospheric Discovery (LEAD) concept involves a series of interconnected IT "environments" that provide a complete framework within which users can identify, obtain, and work with observational, computer model, and user-generated information [Foster, 2001] - and do so in a distributed setting where real time data streams and decision making are important, and where both the problem being addressed and the computational resources can change dynamically with time. The IT research will establish the LEAD Portal, operated within the Local User Environment, which will serve as the user's primary window to the LEAD world. The Portal will provide all linkages to the User Productivity Environment, which contains a broad array of tools, models, and algorithms for operating on and visualizing data and other information made available within the Data Cloud (figure 2).

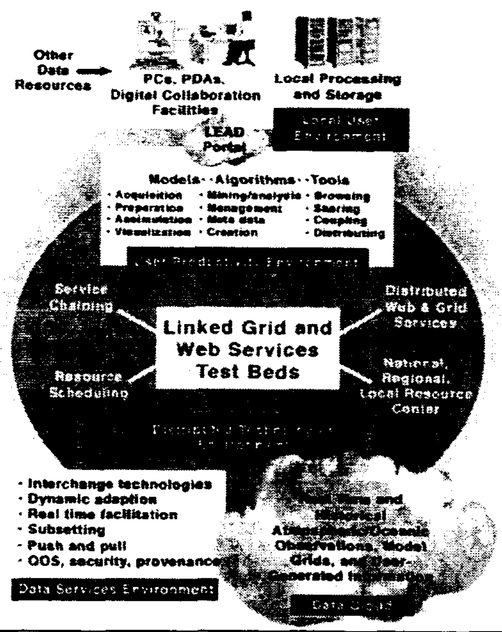
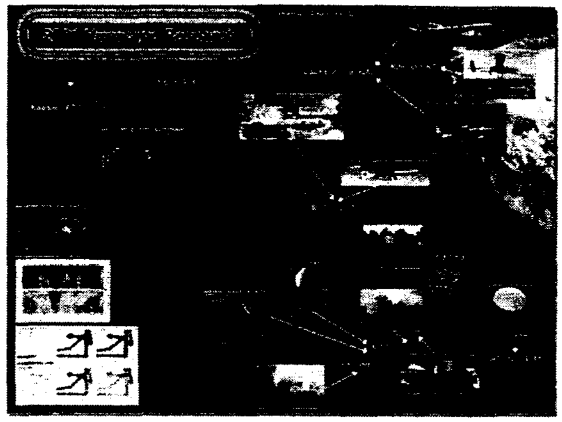


Figure 2: LEAD Grid Example

Complimenting LEAD is a grid effort for Modeling Environment for Atmospheric Discovery (MEAD). The goal of the MEAD expedition is the development/adaptation of cyberinfrastructure that will enable simulation, datamining/machine learning and visualization of hurricanes and storms utilizing the TeraGrid [Conover 2003]. The focus is on retrospective computation and analysis (not real-time prediction). Portal grid and web infrastructure will enable launching of hundreds of individual WRF (Weather Research and Forecasting), Regional Ocean Modeling System

(ROMS), or WRF/ROMS simulations on the grid in either ensemble or parameter mode. Metadata and the resulting large volumes of data will then be made available through the MEAD portal for further study and for educational purposes.

Technologies to coordinate complex projects



http://camex.msfc.nasa.gov

Figure 3: CAMEX example of research management system

RESEARCH MANAGEMENT SYSTEMS

Other systems are being developed to handle the operations of field research campaigns where many different investigators are collaborating on large scale experiments (figure 3), such as the Convection and Moisture Experiment (CAMEX), focused on the study of tropical cyclone (hurricane) development, tracking, intensification, and landfalling impacts using NASA-funded aircraft and surface remote sensing instrumentation. The collaborative IT system developed for CAMEX was able to provide project management and coordination of activities from numerous resources such as aircraft, ground and satellite sensors, and other data sources, in a web-based environment [Conover, 1998].

DATA MANAGEMENT SYSTEMS

The NASA Earth science community has invested a lot of resources into the management and dissemination of scientific data in an effort to handle the vast volumes of data collected daily. A large network of distributed sites are actively archiving, processing and distributing Earth science data and information about the data (metadata). Figure 4 illustrates an example of a "data pool" that provides a web-based search and order interface for online passive-microwave data at the Global Hydrology Resource Center at the National Space Science and Technology Center.

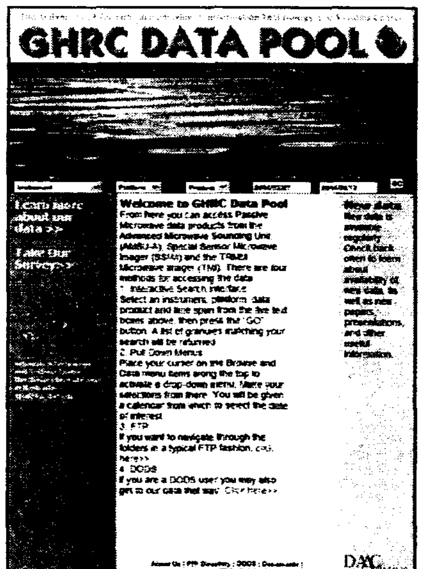


Figure 4: Data Pool example of data management

APPROACH FOR REAP2

For the REAP2 project we have taken the approach of borrowing aspects from several of the technologies mentioned above for incorporation into a solution for propulsion research. The initial prototype is explained in the following sections.

The initial REAP2 portal is primarily informational from the public-accessible page with information about the project, participants and public-viewable documents (see figure 5). A "private", non-public access area on the portal contains project information, documents and publications that are only accessible by the project team members. Email communications between participants is automated through hosted email list servers for easy email dissemination.

To facilitate the sharing of information and the collaboration on reports, the portal includes a mechanism to allow participants to upload documents to the portal through the web interface. This approach allows for direct updates of the portal content without requiring the intervention of a web master and has worked well for collaborating on reports and publications. We use the concept of a "project" document in the case of group reports that require the collection of multiple presentations from the different participants into a final deliverable of presented reports.

One of the REAP2 objectives involves the search and review of historical propulsion documents for information pertinent to these projects. To aid in assist this effort the portal includes an annotated bibliography where participants can provide links to documents under review or planned for review. Annotations and abstracts can then be associated and updated with each document. All participants can view the annotations, but only authorized users may actually provide annotations.

As the project teams progress and expand their collaborations with the other groups it is becoming increasingly necessary to maintain project-specific information. Towards that end modifications are underway to add project level authorizations that will allow members of the same project group access to their own "project" area on the portal. Shared views across the projects will be available for groups to make information accessible to all participants while at the same time keeping tighter control on information that is not ready for broader dissemination.

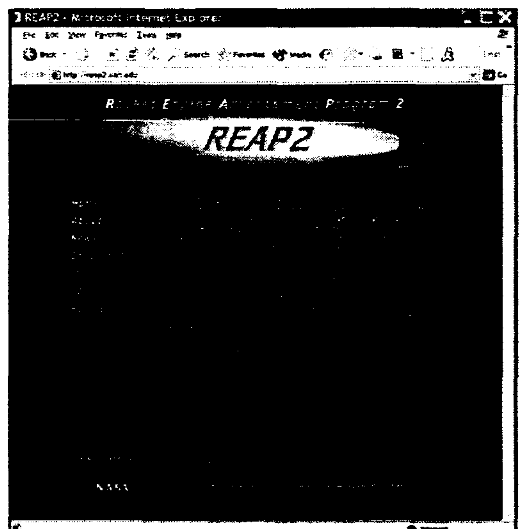


Figure 5: Initial REAP2 Portal Interface

A future goal is to begin experimenting, in the true nature of a processing grid, with linking users directly with experiment equipment that might allow for users to drive and gather results from experiments at remote sites, communicate and visualize results via facilities such as the Access Grid [Karonis, 2003]. Access Grid implementations utilize collection of resources including multimedia large-format displays, interactive presentation environments, and interfaces to Grid middleware and to visualization environments [http://www.accessgrid.org/].

As the REAP2 project advances we will gather possible requirements that may lead us in the direction of creating a Propulsion Research Grid that would open many of these services and capabilities up to the broader propulsion research community.

Quarterly reports, for instance have been orchestrated through video conferences which has been an effective way to get everyone together visually without the expense of travel arrangements and lost production time during transit.

SUMMARY AND CONCLUSIONS

Within the REAP2 project we are making progress towards the integration of collaborative information technologies with ongoing propulsion research project activities. As the project continues we hope to integrate additional capabilities and find even better ways to support the interactions of the research teams. Acceptance and use of the portal capabilities under development will continue to be a challenge, but user participation will only serve to improve the requirements and ultimately the implementation of this system.

FUTURE WORK

A propulsion research information grid is a very real possibility as grid technologies in general mature and we become more knowledgeable of propulsion research data problems and requirements. The possibility of providing online access to research facilities and equipment has the potential of providing improved collaboration between groups as well as making some resources available to smaller groups who might not otherwise have the opportunities of using advanced facilities.

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